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THE GENUS *CLAUSILIA*: A STUDY OF ITS GEOGRAPHICAL DISTRIBUTION, WITH A FEW NOTES ON THE HABITS AND GENERAL ECONOMY OF CERTAIN SPECIES AND GROUPS.

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THE genus *Clausilia* is as interesting a group as any among the land Mollusca. It is well characterized, and stands, to a certain extent, isolated. To the systematist it offers problems of classification, based, in the main, on an examination of the complicated processes which it has developed for closing the mouth of the shell. To the student of distribution, the sphere and limits of its occurrence, which are well marked, may contribute, if handled with reasonable care, evidence bearing on the question of the ancient connexion of lands now widely separated.

An authority on the genus, as great as any who have ever lived, Dr. O. Boettger, regarded *Balea*, with its sinistral spire, its lack of clausilium, lamellæ, and plicæ, and its occasional rudiment of a parietal tubercle, as the progenitor of the Clausiliidæ, and he considered the living *Balea* of the present day, with their very remarkable geographical distribution (Europe, Tristan d'Acunha, South Africa, New Zealand), as salvage from the wreck of the ancient genus strong enough to resist the lapse of ages. *Clausilia* first appears in the Lower Eocene (*Oospira*, *Pseudonenia*) and Upper Eocene (*Disjunctaria*, *Albinaria*?), and is common in the Miocene (*Triptychia*, *Canalicia*, *Eualopia*, *Serrulina*, *Constricta*). Boettger's view was that from an original type possessing neither clausilium, plicæ, nor lamellæ, the present-day forms, with their elaborate oral armature, developed in more or less regular sequence. In confirmation of this view, he pointed out that there occur, in Tertiary formations, *Clausilia* without a clausilium (certain recent *Alopiæ* being probably relics of these), *Clausilia* with rudiments of lamellæ, or with undeveloped plicæ in place of a lunule, and *Clausilia* possessing other indications of developmental stages, and showing transitions from a less to a more specialized form.

H. A. Pilsbry, whose views on *Clausilia* carry great weight, holds (47) that the East Asiatic Clausiliidæ (*Phædusa*) are much more closely related to early Tertiary than to modern European groups. (Boettger indeed suggests that *Eualopia* may be the *Balea*-form originating *Phædusa*.) There is reason to believe that, as in the case of the Belogonous Helicidæ, a common stock of Clausiliidæ spread over Asia and Europe, at least as early as the Eocene period. Subsequent evolution in the East and West has been, he holds, along independent lines, and, as in the Helicidæ, the European stock has forged ahead, while the Oriental, on the whole, looks backward, many groups retaining their old characters.

Habits and Economy.—The habits and mode of life, the food and general economy of the genus have been very imperfectly studied. It would seem incredible, were it not the fact, that although scores of fine and handsome species of *Clausilia*, from e.g. Japan, China, and Tongking, have been discovered and named, scarcely a single word has ever been written on the conditions of life under which even one of them exists. Over fifty species of *Nenia* have been described from South America; all that is known of their life is that one species (*steeriana*, Sykes) lives “on the plains, under stones”, and another (*pampasensis*, Dall) “on cactus and mimosa trees”. It may be hoped that a time is coming when it will be regarded as a sound contribution to scientific knowledge to accumulate facts bearing on the life-history of the Mollusca.

Some groups, *Alopi*a for instance, are found exclusively on limestone rock, and not on all limestone, but only on limestone of a particular formation. *Medora* and *Agathylla* are also rock-loving groups, but while *Alopi*a is extremely partial to shade, and rarely ventures into the sunlight, many species of *Medora*, *Agathylla*, and *Albinaria* hang their white or blue-grey shells in the full rays of the sun. The group *Marpessa*, smooth and lustrous shells, to which our own *laminata*, Mont., belongs, lives on smooth tree-trunks, such as the beech, ash, and sycamore, and I have observed, in the Carpathian forests, that such *Marpessa* as *orthostoma*, Menke, and *marginata*, Zgl., prefer the trunks of young trees, and seldom occur on old ones. Although the forests of Transylvania often grow right up to the face of a cliff, on which *Alopi*a may be swarming in hundreds, you will never find an *Alopi*a on the trees, nor a *Marpessa* on the cliffs. The reason is, that the *Alopi*a devour the decomposed surface of the limestone, on which they find some minute vegetable food, while *Marpessa* and other tree-loving groups find their nutriment on the equally minute organisms which grow on the bark, or in the mosses which gather in the cracks of the trunks. Pine-trees are seldom climbed by *Clausilia*, the resinous nature of the bark probably being disliked, but I have noticed a *Pseudalinda* (*cana*, Held) and a *Pirostoma* (*dubia*, Drap., var.) quite exceptionally on pine-trees 6 feet from the ground.

Again, some species are ground-loving, and seldom venture off the level. Such is our own *Pirostoma rolphii* (Gray), but we must not conclude that all *Pirostoma* are ground-loving; on the contrary, *plicatula*, Drap., and *parvula*, Stud., live habitually on rocks and trees. *Euxina mæsta*, Fér., near Beirût, buries itself among loose stones and earth to a depth of several inches, but probably not all *Euxina* have this habit, although a species (*corpulenta*, Friv.) I met with at Brussa in Asia Minor lives habitually on banks at the roots of grass. A species of *Pseudalinda* (*fullax*, Rossm.), common in the East of Europe, is also a ground-loving shell, living at the roots of bushes and nettles, often under layers of dead leaves, on which it feeds, and seldom mounting rocks. A tiny *Graciliaria* (*filograna*, Zgl.) conceals itself under dead leaves and in cracks on the ground. One notices that species which crawl on the ground and do not hang suspended are often of corpulent habit, while many species which hang are narrow and produced:

mechanical causes may contribute to this result. The group *Siciliaria*, peculiar to Sicily, contains many species remarkable for their latticed ribbing, a feature characteristic of most of the group *Agathylla*. Yet, while *Agathylla* adheres to steep rocks, *Siciliaria* is habitually found under loose and flat stones, often decollated, and disfigured with clay. I am inclined to attribute the frequent decollation of adult specimens of this group to its particular habitat, and shall be surprised if a common Himalayan species, *Cylindrophædusa cylindrica* (Pfr.), which is always decollated, does not live in a similar way.

Two species at least, *Euphædusa tatsui*, B. & S., from Hupé, and *Pirotoma ventricosa*, Drap., from North Europe, are known to be ovoviviparous.

Clausilia is intolerant of extreme cold, a fact which is indicated, not only by its hibernation, even in temperate climates, but also by its general geographical distribution. Early in September, 1913, I was seeking a particular species of *Alopiæ* on the top of a mountain between 6,000 and 7,000 feet high, in Roumania, and was disappointed to find nothing but a few dead shells. At last I discovered plenty of living specimens buried from 6 to 9 inches deep in the soil at the foot of the rocks on which they ought to have been climbing, and it then occurred to me that two or three days before an unusually heavy snowfall had covered the range, and the shells must have concluded that winter was upon them, and disappeared accordingly. No doubt all *Alopiæ* which live at a high altitude (and one species lives at the top of the Butschetsch, 8,230 feet) inter themselves deeply in the earth or in the cracks of the cliffs during the winter months. *Albinaria* æstivates by secreting a paper-like epiphragm, by which it glues itself to the underlying rocks, and prevents evaporation. Like many *Xerophila* and some *Buliminus*, it has a black body beneath a white shell, a fact which no doubt serves some purpose in the animal's economy.

Piaget (45) has made some interesting investigations into the altitude to which certain Swiss species can attain. He found that *parvula* and *ventricosa* do not, as a rule, ascend higher than 1,500 m., *cruciata* and *plicatula* than 1,700, while *dubia* and *laminata* can sustain life at 1,850 m. In warm climates these altitudes are greatly exceeded. *Euphædusa waageni*, Stol., is recorded from Murree, West Himalayas, at 9,000 feet, while *Nenia raimondi*, Phil., is found in Peru at over 10,000 feet, in the Cordilleras. All these heights are surpassed by *sennaariensis*, Pfr., which is stated by Bourguignat to occur on the Abouna Yousef, in Abyssinia, at 4,024 m.

The genus falls, geographically and conchologically, into three great divisions:—

- I. *Clausilia* proper, inhabiting Europe, South-Western Asia, North Africa, and the Madeira group.
- II. *Phædusa*, inhabiting South and East Asia and certain of the East Indian islands.
- III. *Nenia*, inhabiting South America and one West Indian island.

I. *CLAUSILIA* PROPER.

In Northern, Western, and Central Europe *Clausilia* is poorly represented both in sub-genera and species, while in South and South-East Europe (Austria-Hungary, the eastern shores of the Adriatic, Italy, the Balkan Peninsula, Greece and the Archipelago, and Asia Minor (the sub-genera are numerous and often handsome, while individual species abound.

Four hardy sub-genera, *Marpessa*, *Alinda*, *Cusmicia*, *Pirostoma*, have spread over practically the whole of Europe, from Russia to West France and even Portugal, and from Norway to the Mediterranean. On the other hand, the richness of the *Clausilia* fauna of South-East Europe may be estimated from the following enumeration of the principal sub-genera which find their centre there: *Alopi*, *Triloba*, *Idyla*, *Herilla*, *Delima*, *Dilataria*, *Medora*, *Agathylla*, *Pseudalinda*, *Strigillaria*, *Graciliaria*, and others. *Albinaria* is characteristic of Greece and the islands, *Papillifera* inhabits South Europe, especially the coast lands, *Siciliaria* is peculiar to Sicily.

Within the European region there are four well-marked centres of Clausilian development, quite distinct from one another, and all lying to the south or south-east. It is noticeable that three of these are in close proximity to the sea. They are: (1) Dalmatia, (2) Greece and the islands, (3) Transylvania, (4) Asia Minor, Caucasus, and Syria. A very rough estimate gives about 450 species belonging to these four centres, as compared with about 230 species from all the rest of the region.

One is struck by a fact, which could be illustrated from other groups of Mollusca, and no doubt from other branches of zoology. Outlying species of a sub-genus will be found, which have either penetrated into regions far from its centre of occurrence, daring pioneers, as one might regard them, of a possible future extension of range, or in some cases relics of a once wider but now contracting distribution. Thus *corynodes*, Held, reaches East France, though *Graciliaria* finds its metropolis in Eastern Europe; a single *Cristataria* (*stussineri*,¹ Bttg.) occurs in Thessaly, though its metropolis is Syria, and even Asia Minor contains practically no *Cristataria*. *Albinaria* exhibits a remarkable extension both east and west; *degregorii*, Plat., occurring in Malta, and *lopedusæ*, Calc., in Lampedusa Island, while *filumna*, Pfr., is a solitary *Albinaria* in Lebanon. An *Agathylla* (whose metropolis is Dalmatia) is found in Syria, a remarkable record, for *Agathylla* is not otherwise found east of Herzegovina, except for one doubtful record in Macedonia. A species of *Serrulina* (*collasi*, Stur.), a group characteristic of Armenia and Caucasus, has recently been discovered in a cave in Corfu, a clear case of survival, *Serrulina* being only found European in the Miocene. The occurrence of a *Pseudalinda* (*denticulata*, Oliv.) in certain of the North Cyclades is illustrative of the same phenomenon; von Möllendorff regards the species as a *Strigillaria*.

¹ Von Möllendorff regards this species as a *Carinigera*, to be classified with *eximia*, Mdf., and *lophauchen*, Stur.

British Isles.—In Britain we have five species of *Clausilia*, belonging to the four sub-genera *Marpessa* (*laminata*, Mont.), *Alinda* (*biplicata*, Mont.), *Cusmicia* (*dubia*, Drap., *bidentata*, Str.), *Pirostoma* (*rolphii*, Gray). The present distribution¹ of these species in Britain is—

laminata: All England except Cornwall and Hunts, but only in three of the twelve counties of Wales, viz. Glamorgan, Merioneth, Denbigh; Edinburgh, Fife and Kinross, Mid and North Perth, Kincardine; Ireland in six counties only, stretching north-west and south-east from Sligo to Wicklow.

biplicata: Surrey, Middlesex, Herts, Cambs (all adjacent counties), Gloucester East. Rapidly becoming extinct.

dubia: I omit, the range being still under question.

bidentata: All British islands from Jersey to Shetland.

rolphii: All south and south-east counties south of Thames (except Dorset, Somerset, Cornwall), Herts, Northants, Monmouth, Salop, Lincoln (furthest north). Not in Ireland.

The following species, now living on the Continent, have been found fossil only in England: *parvula*, Stud. (Pliocene, Hunts)²; *pumila*, Zgl., var. *sejuncta*, West. (Pleistocene, Cambs, Hunts); *ventricosa*, Drap. (Pleistocene, Hunts); *plicatula*, Drap., from Copford (S. V. Wood, Crag Mollusca, ii, p. 307), is a misidentification for *rolphii*. The following have not been identified with any Continental forms: *striatula*, Edw. (Eocene, Isle of Wight), *pliocena*, S. V. Wood (Coralline Crag, Suffolk).

Scandinavia and Denmark.—Norway and Sweden, from their close connexion with the Continent, are far richer in *Clausilia* than Britain. All our five species occur in one or the other, and Norway possesses three and Sweden four besides. No sub-genus is present which is not also British. The occurrence of a *Papillifera* (*nilssoni*, West.) in Sweden seems very doubtful. *C. rolfii* reaches Christiania,³ *biplicata* and *plicatula*, Bergen, *laminata* has been found at Trondhjem, and *bidentata* as far north as Tromsö (69° 40' N.); *cruciata*, Stud., which reaches Sweden, has not yet been found in Denmark.

Denmark, on the whole, is not a very favourable country for *Clausilia*. Ten species are found, and all the sub-genera are still those of North Europe. Three species occur which are not in Norway and Sweden, viz. *parvula*, Stud. (Zealand, very rare), *pumila*, Zgl. (Zealand and Bornholm, doubtful from Scandinavia), *lineolata*, Held (South and East Fünen only). Schleswig-Holstein shows no addition to the list. There is no *Clausilia* in the North Frisian

¹ The facts are taken in the main from the official records of the Conchological Society, and are kindly furnished me by Mr. W. D. Roebuck. For *bidentata* in Shetland, see Jeffreys, Brit. Conch., i, p. 279.

² I am indebted to the kindness of Mr. A. S. Kennard for this information.

³ The following seems interesting:—

	Furthest north in England.	In Norway.
<i>rolphii</i>	. . . 53° 30' N. lat. 60° N. lat.
<i>biplicata</i>	. . . 52° 30' „ 61° „
<i>laminata</i>	. . . 57° „ 64° „

islands. I have no record of any from the Faroe, nor is there any species in Iceland.

France.—Moquin-Tandon (39) in 1855 catalogued fourteen species as inhabiting France, including two found only in Corsica. France was not so large in 1894 as she was in 1855, but Locard (28) in 1894 enumerated ninety-six species of *Clausilia* from France (not including Corsica), besides four *Nenia*, without the slightest indication of any varieties. A more hopeless wilderness of nomenclature was never constructed.

One group strange to Britain, *Graciliaria*, reaches its western limit in East France (*corynodes*, Held). The group *Lamellifera* (Bourguignat's *Neniatlanta*, see p. 266) is peculiar to the south-west corner of the Pyrenees. *Papillifera* is represented by two or three species in the far south. *P. leucostigma*, Rossm. (a Central and South Italian form), occurs abundantly in the Arènes at Nîmes, evidently introduced some while ago. An Italian *Delima* (*itala*, Mts., var. *punctata*, Mich.), according to Mergier, has passed the frontier, and is advancing westward in Vacluse. Except in the south, the whole fauna is North European.

Corsica possesses only three species, one peculiar (*porroi*, Pfr. = *meissneriana*, Sh.); the other two are the ubiquitous *laminata* and *bidens*.

The Iberian Peninsula.—Hidalgo (23) has catalogued twelve species in all from Spain and Portugal. Some of these are very doubtful. A careful scrutiny gives five species to Spain and perhaps three to Portugal, with one common to both. *Cusmicia* is the chief sub-genus. *Papillifera bidens* occurs on the Eastern littoral, and is also the only *Clausilia* in the Balearic Islands. Nobre (43) admits only two species in his list of Portuguese land Mollusca. Clearly the climate and soil of the peninsula are not favourable to the genus.

Germany and Switzerland.—When we reach Germany the fauna at once assumes a Central European character, which becomes more marked the further south and east we go. *Strigillaria*, *Fusulus* (an Alpine form), *Erjavecica* (in Bavaria), *Graciliaria*, and even *Delima* now appear, the latter only in the Bohemian and Silesian mountains, where *D. ornata*, Zgl., is the only true *Delima* found north of the Alps. *Pirostoma* has now seven species, *Marpessa* three. Half the species, which number about twenty-five to thirty, are widely distributed; about a third are 'Eastern' in origin.

The Alps in the south effectually block the way for the spread of any southern species, and the political distinction between Germany and Austria is calmly ignored by the Mollusca, Bohemia being essentially 'German' and Silesia equally 'Austrian' in character. The presence of a *Graciliaria* (*filograna*, Zgl.) in the Harz Mountains, of a *Strigillaria* (*cana*, Held) as far north as Rügen, and of *rolphii*, Gray, in the north-west only, are to be noted. The Prussian Rhine provinces nourish a *Clausilia* fauna essentially northern in character, and a list from this district by C. R. Boettger (2) scarcely differs from a list from South Sweden.

The *Clausilia* of Switzerland are, as would be expected, of a type

almost entirely northern; the greater altitude balancing the more southern latitude. One observes little that is characteristic in the lists that are published. *Marpessa orthostoma*, Zgl., penetrates to the cantons of Neuchatel, Berne, and Vaud, and is even found in the neighbourhood of Basel. One Alpine species, *Dilataria diodon*, Stud., appears to be peculiar to Canton Wallis. The fauna of the Swiss valleys to the south of the Alps naturally has a North Italian character; *Delima*, for instance, penetrates to the southern base of the mountains, and at Lugano *D. itala*, Mts., is abundant.

Austria-Hungary.—Clessin's work (18) excludes Bosnia, Herzegovina, and Dalmatia, and the group *Alopi*a will be treated of separately. Even with these subtractions the lists include sixty species (and more have since been added), classified as follows:—

Widely distributed species	11
Eastern species	22
Southern species	15
Alpine species	12

The principal features of this rich fauna are (*a*) the great increase of *Marpessa*, 13 spp., six of these being 'southern' and five 'eastern' forms; (*b*) the increase of *Cusmicia* (9 spp.), *Pirostoma* (9 spp.), and *Graciliaria* (5 spp.); (*c*) the appearance of a couple of *Herilla* and *Idyla*, thoroughly East European groups; (*d*) the occurrence of *Pseudalinda* (4 spp.) and *Uncinaria* (8 spp.) in Transylvania, and of *Delima* (4 spp.) in South Tirol and other southern states. The limestone regions of Styria, Carinthia, Croatia, with the Banat in South Hungary, and the Siebenbürgen region in the Far East, are all rich districts, abounding in species. The Velebit range, separating South Croatia from North Dalmatia, is another thickly populated region, from which many new, and some dubious, species are described.

The occurrence of about seventy-two species, sub-species, and varieties of the sub-genus *Alopi*a, which crowd the cliffs of the East Carpathians, and have outliers as far west as Torna, not far from Buda Peth, is one of the most striking features of the European *Clausilia* fauna. Sober considerations may reduce the species to about twenty; at least five of these are destitute of clausilium; some species are dextral, others sinistral, others indifferently dextral or sinistral. The range of individual species is singularly contracted, often to the limits of a solitary mountain-top, a ravine, a limestone cliff. Authors agree in placing the group in close relationship with the extinct *Triptychia* (which lacks clausilium) on the one side, and with *Eualopia* (Lower and Middle Miocene) and *Triloba* on the other. No one who has ever collected *Alopi*a can fail to be struck with its entire divergence, as regards general habits, from any other Clausilian group. A species has been reported from North Greece, and two others from Montenegro (see p. 256); further examination of their true position is desirable.

Bosnia, Herzegovina, and Dalmatia are rich in *Clausilia* beyond any other part of Europe. In North Bosnia we have the huge *Herilla bosnica*, Pfr., and *H. dacica*, Friv., which rank among the largest

European species. *Delima* (about ninety species), *Medora* (twenty-four species), and *Agathylla* (thirteen species) are the characteristic sub-genera, *Medora*, with its smooth, blue-grey shells, ranging from Carniola and Croatia to Cattaro, and (*punctulata*, Küst.) just reaching Italy, *Agathylla*, with its pretty latticed forms, being almost confined to the coast-lands and islands. *Dilataria* abounds in the Velebit region. The group *Heteroptycha*, West., is peculiar to Dalmatia. The common sub-genera of Central Europe are crowded out, and even *Papillifera* scarcely occurs. The whole district bears signs of an individual development hardly to be paralleled in any other region of Europe.

Italy and Sicily.—The Italian peninsula falls into three divisions, northern, central, and southern, while Sicily stands quite apart. Nowhere is there the same rich development, either of genera or species, as on the eastern coasts of the Adriatic. *Delima* is the characteristic group of North Italy; *Pirostoma* and *Marpessa*, abundant in the north, fail in numbers as we go southward. *Papillifera*, on the other hand, is strongest in the south, and has only a few species in the north. *Alinda*, and even *Strigillaria*, pass the Alps, but do not seem to occur in Central or South Italy. The peninsula appears to have developed no characteristic group whatever. A single *Medora* (*punctulata*, Küst.), no doubt a migrant from the East Adriatic, reaches Central and South Italy.

Sardinia has two or three species of *Marpessa*, all peculiar; Elba has only two species of *Papillifera*.

Benoit (1) in 1881 catalogued twenty-five species from Sicily and the neighbouring islands. Since his time many have been added, by the labours of Monterosato and others, not all of which, perhaps, will stand the test of time. The characteristic sub-genus is *Siciliaria*, wholly peculiar to the island. *Papillifera* is common, and there are a few *Delima*, but *Medora*, *Alinda*, and even *Pirostoma* and *Marpessa* appear to be entirely absent. Sicilian influence on North Africa is very marked (see p. 260).

The Maltese group contains some remarkable and peculiar forms of *Papillifera*, a single *Delima* (*imitatrix*, Btg.), and even an *Albinaria* (*degregorii*, Plat.). The solitary island of Lampedusa has a form (*lopedusa*, Calc.) generally assigned to this same group, and marking its furthest westward extension.

Montenegro and North Albania, whose fauna has been catalogued by Wohlberedt (61), are a meeting-ground for East European and Dalmatian influences. The elevated nature of the country differentiates the fauna from that of the North Adriatic littoral. *Medora* and *Agathylla* have only two species apiece, *Delima* has eighteen; on the other hand, there are *Alinda* (three species), *Herilla* (five species), *Pseudalinda* (one species), *Strigillaria* (two species; one is *vetusta*, the common *Strig.* of East Europe). *Triloba*, with two species, is peculiar to this region and Macedonia. The most remarkable fact is the occurrence of two species of *Alopi*, *baleiformis*, Btg., and *durmitoris*, Btg., the former of which has no clausilium. Boettger remarks: "Whether a special name is necessary for this group,

which connects the true Transylvanian *Alopi*a with the Hellenic *Guicciardi*, Roth, cannot be determined until more representatives have been discovered in the intervening mountains."

The chief points to notice in *Bulgaria*, *Macedonia*, *Servia*, and *Turkey* are the occurrence of *Idyla*, a group which touches South Hungary, *Triloba* (one species), and of *Herilla*. *Pirostoma* and *Cusmicia* are rare or wanting, but *Marpessa* (three species), *Alinda* (three), *Pseudalinda* (two), and *Strigillaria* (two) are still represented. East Servia has the peculiar sub-genus *Carinigera*, which shows relationship on the one side to *Cristataria*, on the other to *Papillifera*. The whole district will repay further exploration.

Greece and the Islands.—Characteristic of the Levant, and more particularly of the Greek islands, in which it finds its metropolis, is the section *Albinaria*. O. Boettger, in his well-known monograph (4), enumerates seventy-two species, ranging from (possibly) South Dalmatia to Cyprus, with outliers in Lampedusa to the west, and even in the Lebanon to the east. He remarks with joy that the school of Bourguignat has not yet made any incursion into Græco-Asiatic *Clausiliæ*; but that recently M. Letourneux returned from an expedition to the island of Santorin with three new *Albinaria*, all of which he (Boettger) promptly reduced to mere form or colour varieties of the common *cærulea*, Fér.

The section stands almost alone in Europe in the singularly restricted range of a large number of its species. Thus Crete has more than thirty species, all peculiar; Rhodes, Anaphi, and Skyro each possess their peculiar species; while another group is markedly characteristic of the Ionian Islands and the adjacent mainland. On the other hand, on the mainland, and even on the islands, certain species have a wider range, *cærulea*, Fér., e.g., occurring on almost every island of the Cyclades, and on Eubœa. Some species, particularly of the island groups, can be regarded with more or less certainty as derived from an original form still existent: thus *cærulea* in the eastern islands and *nærosa* in the western have probably given birth to races whose isolation has in time caused them to develop into what we now feel justified in calling distinct species.

Crete stands alone, and is almost isolated: its relation to the Cyclades is slight, with Asia Minor perceptible, with the Morea absolutely none.

Albinaria, especially in Crete, is a rock group, and is distributed by the mountains; *Papillifera* is more characteristic of the plains and low hills, which limit the range of *Albinaria*.

Northern Greece is distinguished by a rich development of the East European and Asia Minor sub-genus *Oligoptychia*, and by special groups of *Papillifera* and *Delima*. Two forms of *Agathylla*, a section essentially Dalmatian, occur, *incohata*, Bttg., in Epirus, and *albicosta*, Bttg., in Macedonia. *Medora* is wanting. The sub-genus *Olympia*, with its single species *olympica*, Friv., is peculiar to Mount Olympus. A single *Alopi*a (*guicciardi*, Roth) occurs on Parnassus. A *Pseudalinda* or *Strigillaria* (*denticulata*, Oliv) is found in the northern islands, and in Andros and Tinos. *Idyla*, a sub-genus confined to upland

forests, stretches from Asia Minor through Turkey and Macedonia to North and Central Greece and Eubœa. Boettger gives a striking proof of the former land connexion with Eubœa. On that island occur *Cl. bicristata*, *thessalonica*, *remota*, and *saxicola* in the mountain districts, *Cl. maculosa*, *negropontina*, and others in the hill lands. The former group is found in quite inseparable forms in the high Parnassus district of Central Greece, the latter in the hill lands of Attica. No doubt the *Clausilia* fauna here antedates the separation of Eubœa from the mainland.

Russia.—Politically speaking, the Russian Clausilias fall into two very distinct groups. Zoologically, it is preferable to regard the northern, or Sarmatian, group as quite separate from the southern, or Caucasian, and to leave the latter to be considered under Asia Minor. Practically no species is common to the two.

The Sarmatian group is simply an easterly or north-easterly extension of the commoner species which are distributed all over North Europe. None of the characteristic South-Eastern European sub-genera find their way into Russia. Species are scarce; most numerous in the north-west, in the Baltic provinces of Finland and Livland, but as we proceed east and south it is not a case of fresh species appearing, as these die out, but the whole Clausilian fauna slowly and steadily vanishes altogether. Thus Braun records fourteen species from the Baltic provinces, Slosarski eight from Poland, Milachevich eight from Moscow, Jelski five from Kief, von Rosen three from Kharkov and two from Nowyi Oskol. Further east still, in lists (Boettger 6, 7), from Poltawa (Perm), Ekaterinburg and Orenburg, which contain a fair number of land Mollusca, no *Clausilia* at all occurs; the genus simply dies out from unsuitability of environment.

I note that the hardy *laminata*, Mont., occurs in Finland, Livland, Petrograd, Kurland, Volhynia, Podolia, Moscow, Kharkov, Kurtk, Caucasus.

Asia Minor, Armenia, Caucasus, the Crimea, North Persia.—This vast district forms a linking region between Europe and Asia, but at the same time does not constitute common ground for the intermingling of western and eastern forms. On the contrary, it contains a *Clausilia* fauna wholly its own, with many peculiar sub-genera, the full investigation of which will doubtless do much to throw light on the problem of the connexion between the Mollusca of west and east.

European groups are barely represented at all. *Albinaria* occurs along the west and south littoral of Asia Minor, and in Cyprus, and even penetrates the higher ground of the interior provinces (*bicolor*, Pfr., *bigibbosa*, Charp.); a *Marpessa* and a *Papillifera* are found at Smyrna, an *Idyla* (*spretta*, Friv.) at Brussa; *Cusmicia pumila* penetrates to North Caucasus, *Alinda plicata* perhaps to Armenia: these are only casual infringements of territory. The one sub-genus of which any considerable number is common to Europe is *Oligoptychia*, which occurs from the South Caspian to Asia Minor, in North Greece, the North Sporades, and Macedonia. The characteristic indigenous sub-genera are *Euxinastra* (near Batum), *Aerotoma*, a group with

relations to *Phædusa*, but differing in the keeled cervix (Transcaucasia), *Mentissa* (peculiar to Crimea), *Eurina*, with nearly forty species (all Asia Minor, Armenia, Caucasia, North Persia, Syria, to Jerusalem), *Bitorquata*, two species (Syria only). Besides these we have *Cristataria*, which is almost confined to the limestone of Syria (twenty species are catalogued by Germain 20), *Micropontica* (Caucasus, three species), which is said by Hesse to have an outlier in the Central Rhodope district (*M. despotina*, Hesse), *Serrulina* (five species), the most eastern group of all, which, according to Nägele, just touches the Amanus Mountains of Asia Minor (*serrulata*, Pfr.) but is characteristic of Armenia, Caucasia, North Persia, and the Elburz Mountains south of the Caspian. Finally, a single species of *Hemiphædusa* (*perlucens*, Bttg.) is reported, on Boettger's authority, from Lenkoran in the Talysch district on the Caspian, and also, *teste* Lindholm, from the Tiflis province. The occurrence of this stray waif of the *Phædusa* group (possibly a survival of a once much wider extension) is a very remarkable fact, and it illustrates the tendency, already noticed, of single outlying species of a sub-genus to occur far from the general area of its distribution. The nearest relations of this outlier of the great *Phædusa* section are found in the North-West Provinces of India, and in two species of *Hemiphædusa* from Prov. Moupin, East Tibet.

Northern and Central Asia.—The vast extent of territory which falls under the comprehensive name of Northern and Central Asia, and measures perhaps 3,500 miles from west to east, and 3,000 from north to south, appears to be wholly destitute of *Clausilia*. Further investigation of these regions, where arid and trackless deserts alternate with cold and wind-swept plateaux, may perhaps discover a few stray species, but, so far, the evidence, which is not scanty, all tends in the opposite direction.

No *Clausilia*, for instance, occurs in a list of shells drawn up by von Martens (33) from East Russia, the Siberian plain, and the Altai district, nor in a list (von Martens 35) of Central Asiatic Mollusca from the mountain districts separating the South Siberian steppes and the Aralo-Caspian deserts from the central highland of Mongolia, and East Turkestan from the Pamirs and the neighbourhood of Lakes Ala-kul and Issik-kul, up to a height of 11,000 feet. The same author (von Martens 34), dealing with Central Asiatic Mollusca—the district including Altai, Changai, Balchash, Issik-kul, Russian Turkestan, Pamir Lakes, Yarkand, Kashgar, Ladák, Tarnur and Chami, and Kukanor—remarks that so far *Clausilia* has not been found there, nor are any recorded in his special memoir (von Martens 32) on the Mollusca of Turkestan. G. Nevill (42), recording the results of the second Yarkand Mission, records no *Clausilia* from East Turkestan and Ladák, nor from Kashmir, while Westerlund, dealing with Siberian land and freshwater Mollusca, under the headings of Siberia proper, east and west Baical region, Altai region, Amur district, Kamschatka, includes no *Clausilia* in his list. Even in a memoir on a district much nearer to Europe, Transcaspia, and Khorassan, a district lying roughly from the eastern shore of the

Caspian to 64° E. long. and from 42° to 35° N. lat., O. Boettger (8) records no *Clausilia*.

Northern Africa.—The fauna has received the attentions of Bourguignat and his school, and counsels are darkened accordingly. On the whole, the district is not favourable for *Clausilia*. Twelve species have been enumerated from Tunis, consisting of *Delima* (seven species, marking the connexion with Sicily), *Papillifera* (three), *Marpessa* (one), unknown (one). The list is susceptible of reduction; all the *Papillifera* are possibly varieties of the ubiquitous *bidens*. Sturany has described a *Delima* (*klaptocki*) from Dernah, in Barca. The entire absence of *Siciliaria* appears to indicate that the development of that sub-genus in Sicily must have been later than the separation of Sicily from Africa. The genus, as on the north of the Mediterranean, dies out as we move westward, Algeria having fewer species than Tunis, Morocco than Algeria. *Cristataria boissieri*, Charp., from Syria, has been acclimatized at Algiers, and also near Alexandria.

Of the *Atlantic Islands*, the Madeira group alone contains any *Clausilia*. On the two islands of Madeira and Porto Santo three or four species occur, grouped under the sub-genus *Boettgeria*, which is regarded as having some relationship with *Agathylla*. The islands have evidently been separated from the mainland for a very considerable length of time, since their molluscan fauna exhibits marked peculiarities of its own.

Central Africa.—The occurrence of a small number of *Clausilia* in intertropical Africa is a fact of extreme interest. Three species (*sennaariensis*, Pfr., *dystherata*, Jick., *rothschildi*, Neuv. & Anth.) have been discovered in the highlands of Abyssinia, in or near to Eritrea, and the latter authors (41) found, but did not describe, a fourth species from the same district. The two former species were placed by O. Boettger in his sub-genus *Macroptychia*. From the other side of the Red Sea von Martens has described a species (*schweinfurthi*) from Yemen, 7,500 feet, and Jousseume found an undescribed species in a ravine near Djeddah. Geographically speaking, these six species may be considered as belonging to the same group, since they all inhabit lofty mountains looking down on both sides of the southern Red Sea. The type of shell appears to be dwarfed and degenerate. Further specimens are much to be desired, but it seems probable that these species may represent the worn-out remains of a Clausilian fauna which may have been richer in past ages, and has dwindled and decayed under change of climate.

About 700 miles from the habitat of these six species, a seventh, apparently belonging to the same type, has recently been described (*degeneris*, Prest.) from between Rumruti and Mt. Kenia, almost on the Equator. From Mt. Kenia to the southern end of Lake Tanganyika is another 700 miles, and from Pambété Bourguignat in 1885 described yet another species (*giraudi*). It was found “dans les anfractuosités des rochers”, is well grown, and possesses a marked sub-columellar fold below and behind the lamella inferior. Bourguignat (14) remarks that “this new species, by its sub-columellar fold, which descends to the peristomal border, recalls certain Chinese forms like

pluviatilis, while by its outline and papilliform suture it has certain points of resemblance with *itala* or *punctata*".

Whatever its affinities may be—and it has plainly no resemblance to the Abyssinian group—the occurrence of an African *Clausilia* in S. lat. 8°, at a height of about 3,000 feet, is a remarkable phenomenon. With this exception the *land* molluscan fauna of Tanganyika has, I think, shown no special feature of peculiarity. We must await the detection of further species.

Two expeditions to Ruwenzori have failed to discover *Clausilia* on its slopes (Smith 53, Pollonera 50). Nor does it occur in Socotra or in Swahiland (von Martens 30).

II. PHÆDUSA.

India and Further India.—The *Clausilia* of India have recently been catalogued by G. K. Gude (21). India (with Ceylon), Further India, including Burmah, Arakan, Tenasserim, the Andaman and Nicobar Islands, and Indo-China (Tongking, Siam, Annam, and Cambodia), form practically a single zoological area, whose molluscan fauna is closely related to that of South China.

Mr. Gude has enumerated thirty species in all from India and Further India, belonging to the sub-genera *Euphædusa* (nine), *Pseudonenia* (twelve), *Oospira* (five), *Cylindrophædusa* (two), *Garnieria* (two). In India proper all the known species (only nine) cling to the mountain slopes of the north, and not a single species occurs between the Himalayas and Cape Comorin. Ceylon has a single *Euphædusa* (*ceylanica*, Bens.), which occurs at 4,500 feet in the central mountain mass. The Himalayan forms fall into two well-marked groups: (1) those inhabiting the Punjab and North-West Provinces, (2) those inhabiting Sikkim, Bhutan, and Assam. No species has as yet been recorded from Nepal, which covers a length of 500 miles between these two groups, and only one species (*Cylindrophædusa cylindrica*, Pfr.) is common to the two. *Euphædusa* has one species in the western group and three in the eastern. *Pseudonenia* has none in the western and three in the eastern. No *Clausilia* has been found in Kashmir proper, Afghanistan, or Beloochistan.

In Further India the *Clausilia* fauna becomes richer and more distinctly Chinese: of *Euphædusa* there are five species, and of *Pseudonenia* six; *Cylindrophædusa* disappears, but two new sub-genera occur, *Oospira*, with five species, and *Garnieria*, a form with a remarkable trumpet-shaped mouth, with two. The Nicobars, which belong geologically to Sumatra rather than to the mainland, have three species of *Pseudonenia*. One specimen, unnamed, is recorded in G. Nevill's Handlist as coming from the Andamans.

Indo-China.—Indo-China (Tongking, Siam, Annam, and Cambodia) becomes definitely Chinese so far as its *Clausilia* are concerned, Tongking, in the far north, being especially rich, and containing several 'Chinese' species. H. Fischer and Dautzenberg in 1904 (19) enumerated fifty-five species in all, and since that date at least twenty more have been added by Bavay & Dautzenberg, H. Fischer, and

others. *Garnieria*, with eleven species, here attains its maximum, and the other characteristic sub-genera of China are well represented, some by forms of remarkable size and beauty. The low-lying districts, drained by the Menam and Mekong Rivers, are practically destitute of species, all the finer forms coming from the high ground of Tongking.

China.—The *Clausilia* fauna of China is among the richest in the world, but is at present only imperfectly known. Certain portions of this vast empire have been worked with something approaching thoroughness, others have been occasionally visited by the collector, while others have never been visited at all. Under these circumstances it would be misleading to attempt to come to any conclusions, based upon apparent abundance or scarcity of *Clausilia* in any particular province, as compared with any other. But we do know enough to state broadly that the provinces watered by the upper and middle Yang Tse Kiang, East Sytschouan, and Hupé (Hubei), with Hunan to the north and Yünnan to the south-west, are exceedingly rich in *Clausilia*. Père Heude (22) in 1882–90 noted no less than seventy-one species, sixty-two of which were described as new. Many of these are among the largest and handsomest species of the genus, rivalling, but not surpassing, the giant forms produced by Japan. Since Heude's time great additions have been made to the list, notably by Bavay & Dautzenberg, by Gredler, Schmacher and O. Boettger, von Möllendorff, Sykes, and others. China is the metropolis of the fine sub-genera *Euphædusa*, *Formosana*, *Hemiphædusa*, and *Macrophædusa*, while *Pseudonenia* is well represented in the south, and *Garnieria* and *Oospira* reach the southern provinces. At least 120 species in all are known.

In the west and north-west *Clausilia* becomes relatively scarce. A fine species has recently been described (*Cl. cookei*, Prest.) from South Shensi, but, as von Möllendorff remarks (38), from the rich development of the genus in Hupé and the neighbouring East Sytschouan, it might have been expected that in the well-wooded and mountainous region of West Sytschouan a number of new species would have occurred. This, however, is not the case, and as a matter of fact the distribution of the genus dies out rapidly to the west and north-west. This is a fact of considerable zoogeographic importance. In the genera *Cathaica* and *Buliminus* the centre of distribution and richest number of species occur in Upper Amdo, still further west, but they rapidly fall off as we move east and south-east, and in South China die out almost altogether. The opposite is the case with *Clausilia*, which is strongest in South China; relatively only a few species reach North Sytschouan, none overpass the borders of Gansu, in spite of the fact that Gansu is otherwise very rich in land Mollusca.

In the colder and less mountainous regions of North-East China, *Clausilia* appears to be very infrequent. A list of Mollusca from Dschili (capital Pekin), drawn up by von Möllendorff, contains no *Clausilia*.

Three species from Province Moupin, East Tibet, were described many years ago by Deshayes. They have not yet been rediscovered,

but have been placed by von Möllendorff, *tibetana* in subg. *Formosana*, *serrata* and *gibbosula* in subg. *Hemiphædusa*. They represent, with one exception, the furthest known western outposts north of the Himalayas of the great *Phædusa* group.

Japan.—The *Clausilia* of Japan, while very closely related to those of China, exhibit in many respects an independent and characteristic development. The whole group has been worked out by H. A. Pilsbry with a thoroughness and originality which are quite beyond praise, and his writings form practically the sole material for a study of the genus as it exists in these islands.

Southern Japan and Formosa are separated from the mainland of Asia by a shallow sea, which in no place exceeds a depth of 200 m. The Loo Choo Islands, which link Japan with Formosa, are separated both from Japan and from Formosa by much deeper water, the archipelago to the south of Kiu Siu (Tanegashima and the Linschoten Islands) being practically part of that island, and separated by deep water from the Loo Choos proper. In the result we find that while the *Clausilia* of Japan and Formosa are closely related to those of China, those of the Loo Choos are markedly different, not only from China, but from Formosa and Japan. To quote from Pilsbry (46): "*Luchnophædusa* has been found nowhere else but on this group [one species on islands off Kiu Siu]. *Zptyx* extends into the southernmost provinces of Kiu Siu, and, probably borne by the Kuro Shiwo, has reached Hachijo, an islet 100 miles off Izu province. *Stereophædusa* and *Hemiphædusa* range further, being common throughout Japan . . . but the species of the Loo Choo Islands belong to a special group of *Hemiphædusa* which has not been found elsewhere. The sections *Euphædusa* and *Megalophædusa*, so characteristic of Japan, are wanting in the Loo Choos. As regards *species*, not one is common to the Loo Choos and any other land. No characteristic Formosan forms of *Clausilia* have been found in the Loo Choo group." "As a whole the *Clausilia* of this group are more specialised than those of China or Japan, and bear out the proposition that insular faunas age more rapidly than those of larger or continental areas" (Pilsbry 46).

The southern and central portions of Japan proper (Kiu Siu and its outliers, Shikoku, Southern and Central Hondo) are rich in *Clausilia*, some species of the sub-genus *Megalophædusa* being the largest and handsomest in the world. In Northern Hondo and Yesso the numbers appear to fall off rapidly, though probably exploration is not complete. Excluding synonyms and varieties, the total number so far recorded for the whole group is about 155, of which 107 occur in Japan proper, 33 in the Loo Choos, and 15 in Formosa.

	Japan proper.	Loo Choos.	Formosa.
<i>Hemiphædusa</i> group	77	12	9
<i>Zptyx</i> group	9	20	4
<i>Euphædusa</i> group	21	1	2
	107	33	15 ¹

¹ Including *Euph. aculus*, Bens., which also occurs in Japan.

The full classification is as follows:—

<i>Hemiphædusa</i> Group.	<i>Zaptyx</i> Group.
1. <i>Megalophædusa</i> .	1. <i>Hemizaptyx</i> .
2. <i>Hemiphædusa</i> .	2. <i>Heterozaptyx</i> .
3. <i>Formosana</i> .	3. <i>Zaptyx</i> .
4. <i>Tyrannophædusa</i> .	4. <i>Stereozaptyx</i> . ¹
5. <i>Nesiophædusa</i> . ¹	5. <i>Parazaptyx</i> . ¹
6. <i>Luchuphædusa</i> .	6. <i>Metazaptyx</i> .
7. <i>Oophædusa</i> .	7. <i>Diceratozaptyx</i> . ¹
8. <i>Stereophædusa</i> .	8. <i>Oligozaptyx</i> . ¹
	9. <i>Idiozaptyx</i> . ¹
<i>Euphædusa</i> Group.	10. <i>Selenozaptyx</i> . ¹
1. <i>Pseudonenia</i> .	11. <i>Thaumatoptyx</i> .
2. <i>Euphædusa</i> .	

“In Korea, Japanese forms dominate over Chinese forms. The submergence of the straits between Kiu Siu and Korea is hence a geologically recent event, probably not earlier than the Pliocene period. All the genera and sub-genera of the Korean molluscan fauna occur in Japan. In the *Clausilias* all the species [five in number] of Quelpart and Korea belong to *Euphædusa*, a group of minor importance in Japan, but extending further north on the Asiatic mainland than any other group of *Clausilia*” (Pilsbry 48).

Malay Peninsula and East Indian Islands.—The Malay Peninsula forms practically the first of the group of great islands which is continued by Sumatra and Java. The fauna is not very well known, but the *Clausilia* belong only to those groups which occur on the islands. About four or five species, all *Pseudonenia* or *Euphædusa*, have been described from Perak, Penang, Kelantan, and elsewhere.

Further exploration of the great East Indian islands will no doubt add much to our knowledge of their Mollusca. But we already know enough to see that as we go eastward *Clausilia* steadily dies out. *Euphædusa* and *Pseudonenia* include the bulk of the species. *Aerophædusa*, Bttg., is peculiar to Java, and *Paraphædusa*, Bttg., to Celebes. Borneo contains two species of *Formosana*, a Chinese and Formosan group. No species appears to be common to any two islands, except *eumingiana*, Pfr., which in one or other of its varieties occurs in the Philippines, Sulu Islands, Celebes, Sangir, Halmahera, and Ternate, and *recondita*, Sykes, which is common to Sumbawa and Halmahera. It is remarkable that so far only one species has been discovered in the Philippines, which are not only nearest to Formosa but have also been better searched than any other group.

From Sumatra we have 7 species, Java 10, Borneo 4, Celebes 10, Philippines 1, Sulu 2, Sangir 1, Sumbawa 1, Halmahera and Ternate 2, Selangor 1. Molluscan lists from the following islands have been published, but do not contain any *Clausilia*: Lombok, Buru, Tenimber, Batchian. Nor has any species as yet been described from New Guinea, though the genus may well exist in the higher mountain ranges of that great island, and anything seems

¹ Peculiar to Loo Choo group.

possible after the discovery, by von Möllendorff, of *Carychium*, *Acanthinula*, and *Pyramidula*, on the high regions of Java.

A list of the known species is subjoined; the date is the date of description.

SUMATRA.

- 1864.¹ *Pseudononia sumatrana*, Mts.
 1864. *P. excurrens*, Mts.
 1867. *Euphædusa obesa*, Mts.
 1891. *Pseudononia alticola*, Mts.
 1893. *Euphædusa ænigmatica*,
 Sykes.
 1893. *E. melvilli*, Sykes.
 1906. *E. robustior*, Bullen.

JAVA.

1841. *Pseudononia javana*, Pfr.
 1842. *P. corticina*, Busch.
 1842. *P. orientalis*, Busch.
 1847. *Acrophædusa cornea*, Phil.
 1847. *A. junghuhnii*, Phil.
 1847. *Pseudononia heldii*, Küst.
 1849. *P. heldii*, var. *moritzii*, Mouss.
 1890. *P. salacana*, Bttg.
 1897. *P. schepmani*, Mdff.
 1897. *P. nubigena*, Mdff.
 1897. *P. fruhstorferi*, Mdff.

BORNEO.

1854. *Formosana borneensis*, Pfr.
 1868. *F. schwaneri*, Herkl. (Pfr.).
 1889-1901. *Euphædusa dohertyi*,
 Bttg.
 1903. *E. (?) filialis*, Mts.

PHILIPPINES (I. Siquijor).

1845. *Euphædusa cumingiana*, Pfr.

SELANGOR.

1845. *Euphædusa cumingiana*, Pfr.
 1897. *E. cumingiana*, Pfr., var.
simillima, Smith.

CELEBES.

1845. *Euphædusa cumingiana*, Pfr.

1864. *E. cumingiana*, var. *molucensis*, Mts.
 1883. *E. cumingiana*, var. *majuscula*,
 Tapp.-Can.
 1897. *E. cumingiana*, var. *simillima*,
 Smith.
 1912. *E. cumingiana*, var. *kabaëna*,
 Haas.
 1896. *Paraphædusa subpolita*, Smith.
 1896. *P. usitata*, Smith.
 1896. *P. celebensis*, Smith.
 1896. *Euphædusa alternata*, Mdff.
 1897. *E. pyrrrha*, Sykes.
 1897. *E. makassarensis*, Sykes.
 1897. *E. balantensis*, Sykes (= *celebensis*, Bttg., nec Smith).
 1899. *E. bonthaiensis*, Sar.
 1899. *E. minahassæ*, Sar.

SULU ISLANDS.

1845. *Euphædusa cumingiana*, Pfr.
 1864. *E. cumingiana*, var. *molucensis*, Mts.
 1894. *Pseudononia suluana*, Mdff.

SANGIR.

1845. *Euphædusa cumingiana*, Pfr.
 1864. *E. cumingiana*, var. *molucensis*, Mts.

SUMBAWA.

1894. *Pseudononia recondita*, Sykes.

HALMAHEIRA AND TERNATE.

1845. *Euphædusa cumingiana*, Pfr.
 1864. *E. cumingiana*, var. *molucensis*, Mts.
 1894. *Pseudononia recondita*, Sykes.

III. NENIA.

Clausilia is conspicuously absent from the list of those genera which are described as 'circumpolar', and is thus entirely wanting in the Nearctic Continent. Although well represented in South America, even on the Equator, it has not succeeded in entering North or even Central America via the Isthmus of Panama. Probably the more low-lying and therefore hotter countries of this region are unsuitable

¹ The dates are the dates of the year in which the species or variety was described.

for a genus whose neo-tropical representatives appear to live at high altitudes.

The two outstanding facts which characterize the distribution of the genus as a whole are its occurrence in South America and its non-occurrence in North America, and perhaps, of the two, the latter is the more remarkable. In spite of the land connexion, more or less intimate, which must have linked Europe with North America, probably during the Miocene epoch, *Clausilia*, although abundant in Central Europe, and even occurring in England, during the Eocene period, did not make its way into North America. It is conceivable that *Clausilia* was originally an inhabitant of warm climates only, and that the sub-genera which now exist in the colder climates of North Europe were not then developed. *Marpessa*, *Alinda*, *Pirostoma*, and *Cusmicia* do not, as a matter of fact, occur earlier than the Pleistocene.

The shell of *Nenia* is invariably sinistral; the aperture is rounded and wide, set on a protraction, more or less pronounced, of the last whorl, and lies exactly in a line with the axis of the spire. Fifty species in all are known—forty-nine from the South American mainland, one from Porto Rico. On the mainland they range from the Sierra Nevada de Santa Martha, lat. 11° N., in the extreme north of Colombia, to about 17° S. lat., in Bolivia. Along the Cordilleras some species lie on the western slope, rather more on the eastern. I have noted one (*malleolata*, Phil.) from 79° W., not 100 miles from the Pacific, while the easternmost hitherto recorded lives in 63° W. lat. The north and south range is thus nearly 2,000 miles, while the eastern and western range is comparatively narrow.

Nine species occur in Colombia, two in Venezuela, one in Colombia, Venezuela, and Ecuador, one in Colombia and Peru, one in Upper Amazons, Peru, and ? Colombia, ten in Ecuador, twenty-one in Peru, two in Bolivia, two in "South America".

The occurrence of a single species in Porto Rico is a remarkable fact, and points to a former geological connexion, more or less intimate, between that island and South America. There can be little doubt that the connexion was via the Lesser Antilles, and not via the Peninsula of Yucatan. This view is supported by the presence, in Porto Rico and in one or other of the Lesser Antilles, of the genera *Leptinaria*, *Morchia*, and *Peltella*, all of which are South American but not Central American genera. It would be interesting if *Nenia* were discovered in the highlands of San Domingo, an island closely connected with Porto Rico, and hitherto imperfectly explored.

The relation of the neo-tropical Clausilias with those of the Palæartic region involves a zoological problem of the highest possible interest, the solution of which is at present quite undetermined. The group *Laminifera*, represented by one or two living species in the West Pyrenees, and by six or seven species in the Miocene and Oligocene of Germany, certainly exhibits points of similarity with *Nenia*, as was shown by Bourguignat long ago. He (12) regarded the two groups as standing in close relation to one another, naming the American *Nenia Neniastrum* and the French *Neniaatlanta*. A more prudent

view will regard *Laminifera* as a possible link between *Nenia* and the Clausilias of the Old World. It is conceivable that the now existing species of *Laminifera* represent the relics of a group whose progenitors were not only more widely distributed in Europe, but also succeeded in emigrating, by what route we are not in a position to say, into the region we now call South America. There can be little doubt that instances occur of similar survivals, which have, by taking refuge, as it were, in mountain fastnesses, victoriously defied (to use Boettger's phrase) the attacks of younger and better organized groups. In this connexion may be mentioned the group *Olympia* (Mt. Olympus), *Serrulina* (Armenia and North Persia, and fossil from the Miocene of Bohemia and Silesia), *Alopiæ* (Carpathians), and possibly *Macroptychia* (Abyssinia).

The only other living group which shows a production of the last whorl, with a continuous peristome, is *Garnieria*, from Indo-China, a sinistral group, in which the mouth is set, as in *Nenia*, exactly in a line with the axis of the spire. The general facies of the group now inhabiting Madeira (*Boettgeria*) is not markedly akin to *Laminifera*, and therefore cannot be cited as supporting a theory of Atlantidean migration. Professor Gwatkin assures me that the radulæ of the few species of *Nenia* which he has been able to examine are of the same general type as that of the Palæartic *Clausilia*. Further light may be thrown by a detailed examination of the clausilium.

LIST OF THE PRINCIPAL WORKS QUOTED.

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